



2013 Washington State Enhanced State Hazard Mitigation Plan

Hazard, Risk, and Vulnerability Primer

The Hazard Mitigation Strategist charged with updating the 2010 Washington State Enhanced Hazard Mitigation Plan and the State Hazard Mitigation Action Team (SHMAT) used the information in this primer to inform their deliberations on improvements for the 2013 plan. Definitions and methodologies for risk, hazards, and vulnerability can set a baseline while allowing for the inclusion of new information and data. Although the United States and Canada face similar if not identical hazards, each country has a slightly different lens to view hazards, risks, and vulnerabilities. Science, technology, and knowledge keep evolving. The 2013 plan update does a good job of capturing the current state of mitigation planning and state activities. There is always room for innovation. The information below provides a good starting point to begin the next update cycle.

Information from the Washington State Hazard Identification Vulnerability Assessment, 2009

Risk Matrix

The following criterion generated a risk matrix of the hazards that are included in the hazard assessments section of this document.

Frequency of Occurrence	1 Catastrophic	2 Critical	3 Marginal	4 Negligible
(A) Occurs Annually	1A	2A	3A	4A
(B) 1-10 year Occurrence	1B	2B	3B	4B
(C) 10-50 year Occurrence	1C	2C	3C	4C
(D) >50 year Occurrence	1D	2D	3D	4D

(Risk table in the HIVA identifies one or more of these impacts; for a combination of impacts from within different categories a judgment was made to assess which of these categories that the event would fall into)

Hazard Category Definitions

Catastrophic: People dead or injured is greater than 10,000; Economic impact is greater than 2% of State GDP; Environmental impact is greater than 15% of a single habitat or species; Property Damage is greater than \$500 million dollars.

Critical: People dead or injured equals 1,000 to 10,000; Economic impact equals 1 to 2% of State GDP; Environmental impact is between 10 -15% of a single habitat or species; Property damage is \$100 to \$500 million dollars.

Marginal: People dead or injured is 500- 1,000 people; Economic impact equals 0.5% to 1.0% of State GDP, Environmental impact is between 5- 10% of a single habitat or species; Property damage is between \$50-\$100 million dollars



2013 Washington State Enhanced State Hazard Mitigation Plan

Negligible: People dead or injured totals less than 500; Economic impact is 0.1% - 0.5% of State GDP;
Environmental impact is less than 5% of a single habitat or species; Property damage is less than \$50 million dollars

Risk Classification	Risk Criteria
1A, 1B, 2A,	Risk mitigation required to reduce risk to level C or D
1C, 2B, 2C, 3A, 3B	Risk mitigation required to reduce risk to level C or D
1D, 2D, 3C, 4A, 4B	Risk mitigation to reduce risk to level D is optional
3D, 4C, 4D	No further risk mitigation is required

HIVA Hazard Category Risk Identification





2013 Washington State Enhanced State Hazard Mitigation Plan

Hazard Identification

County/City Plans

Current plans from each county and participating city were reviewed and their identified hazards listed in Appendix A. The list was reviewed by EMD staff members and grouped by similar hazards. Additional hazards were identified and then the criteria was applied to determine which of the total hazards were to be included in this document.

Criteria

It is important to select hazards, which cause the greatest impact to the State of Washington. The selection process utilized impact thresholds as indicated below. A hazard that met two or more thresholds is included in the assessment section.

Frequency	Annual Occurrence
People	1,000 or more lives lost
Economy	1% State Gross Domestic Product (GDP) loss ~ \$ 3 billion
Environment	10% or more loss of a single species or habitat
Property	\$100 million or more in loss damages

Risk Level

Using the thresholds above, an arbitrary scale was created to quickly present a visualization of the potential losses for each hazard. The table uses different colors to distinguish criterion. It indicates four levels. The first level is equal to the minimum criteria. The fourth level equals the worst-case scenario. The second and third levels provide intermediate losses.

Frequency	50+ yrs	10-15 yrs	1-10 yrs	Annually
People	1,000	1-10,000	10-50,000	50,000+
Economy	1% GDP	1-2% GDP	2-3% GDP	3%+ GDP
Environment	10%	10-15%	15-20%	20%+
Property	\$100M	\$100-500M	\$500M-1B	\$1B+

Selection

The hazards selected below were identified using the risk level thresholds:



2013 Washington State Enhanced State Hazard Mitigation Plan

- Avalanche – Frequency and People
- Columbia Generating Station – People, Economy, Environment, and Property
- Dam Failure/Levee Break – Frequency, People, Economy, and Property
- Drought – Frequency, Economy, and Property
- Earthquake – Frequency, People, Economy, and Property
- Epidemic/Pandemic – Frequency, People, and Economy
- Urban Fire – Frequency and Property
- Wildland Fire – Frequency and Property
- Flood – Frequency, People, Economy, and Property
- Incident, Chemical – Frequency and People
- Incident, Radiological – Frequency, People, Economy, and Property
- Infestation – Frequency, Economy, and Property
- Landslide – Frequency and Property
- Pipelines – Frequency, Economy, and Property
- Severe Storm – Frequency and Property
- Terrorism (inc. Cyber & WMD) – Frequency, People, Economy, and Property
- Tsunami – Frequency, People, Economy, and Property
- Umatilla Chemical Depot – Frequency, People, and Economy
- Volcano (including Ash Fall & Lahar) – Frequency, People, Economy, and Property

Symbolization

When displaying a hazard incident on a map we use standard symbols as agreed on by the Federal Geographic Data Committee - Homeland Security Working Group Symbolology Reference whenever possible. If a standard symbol is unavailable, we have adopted or created one.



HAZARDS	COUNTY																																							
	Adams	Asotin	Benton	Chelan	Columbia	Cowlitz	Douglas	Ferry	Franklin	Garfield	Grant	Grays Harbor	Island	Jefferson	King	Kitsap	Kittitas	Klickitat	Lewis	Lincoln	Mason	Okanogan	Pacific	Pend Oreille	Pierce	San Juan	Skagit	Skamania	Snohomish	Spokane	Stevens	Thurston	Wahkiakum	Walla Walla	Whatcom	Whitman	Yakima			
Abandoned Underground Mine																																								
Airplane Crash																																								
Military Aviation Accident																																								
Avalanche																																								
Chemical																																								
Chemical Spills																																								
Civil Disorder																																								
Civil Disturbance																																								
Civil Unrest																																								
Columbia Generating Station																																								
Hanford Site																																								
Dam Failure																																								
Columbia River Dam Failure																																								
Mill Creek Dam Failure																																								
Snake River Dam Failure																																								
Crime																																								
Workplace Violence																																								
Disease/Epidemic																																								
Epidemic																																								
Intestation Disease																																								
Drought																																								
Water Shortage																																								
Earthquake																																								

Appendix 1 Hazard, Risk, and Vulnerability Primer

Page 6



2013 Washington State Enhanced State Hazard Mitigation Plan

Information from Emergency Management Accreditation Program

EMAP Standard 4.3.1, Sept. 2007

The program shall identify the natural and human-caused hazards that potentially affect the jurisdiction using a broad range of sources. The program shall assess the risk and vulnerability of people, property, the environment and the program/entity operations from these hazards.

To determine the hazards to include in the HIVA, analysts considered each of Washington's local jurisdiction HIVA documents along with the other prominent state or nationwide hazards. After setting a minimum threshold for inclusion for each of the four categories of people, economy, environment, and property, this list of hazards was narrowed down to the eighteen hazards included in the HIVA.

Analysts conducted extensive research into the history and vulnerability for each hazard and included a risk assessment using subject matter experts, publications, and the best-known science and technology on the subject. Based on this research, analysts generated a risk table for each hazard section with a best-known estimate of the hazard's potential effects. In addition, the risk assessment included the potential impacts each hazard poses to the people, economy, environment, and property of the state. Also included with each hazard section are the possible or known impacts that climate change may pose to the risk of such event or the severity or frequency of the occurrence of the hazard.

Technological Hazards

- Technological hazards included in the HIVA are pipelines, dam failure, incident-chemical, incident-radiological, Umatilla Chemical Depot, Columbia Generating Station, and terrorism (including cyber-terrorism and weapons of mass destruction).
- All of the technological hazards included in the document have low to minimal risk but have potential for a high degree of impact should one of these events occur.
- Research material to determine risk and vulnerability of these hazards was difficult to find and relied on subject matter experts when available.

Natural Hazards

- Natural hazards included in the HIVA are: avalanche, drought, earthquakes, epidemic/pandemic, urban fire, wildland fire, floods, infestation, landslide, tsunami, severe storms, and volcanoes (including ash fall and lahar)
- These natural hazards occur more frequent than the technological hazards and have a history of causing a high degree of impact to the people, economy, environment, and property of the State.
- Research material including scientific publications to determine risk and vulnerability are readily available for most natural hazards. We relied upon subject matter experts to provide guidance and clarification during the writing and editing process.

The natural and technological hazards included in the HIVA are those hazards considered having the highest degree of impact or frequency of occurrence that adversely affect the people, economy, environment, and property of Washington. While mitigation and personal preparedness efforts can



2013 Washington State Enhanced State Hazard Mitigation Plan

lessen the impact and severity of natural and technological hazards, the risk and vulnerability cannot be eliminated.

Although the risk of these hazards cannot be completely eliminated, with mitigation and preparedness efforts a good assessment of risk and vulnerability can guide emergency managers toward those hazards that are in need of mitigation and preparedness plans. With these plans, the state and local jurisdictions can better prepare for and respond to disasters, limiting their impact to the people, economy, environment, and property of Washington.



2013 Washington State Enhanced State Hazard Mitigation Plan

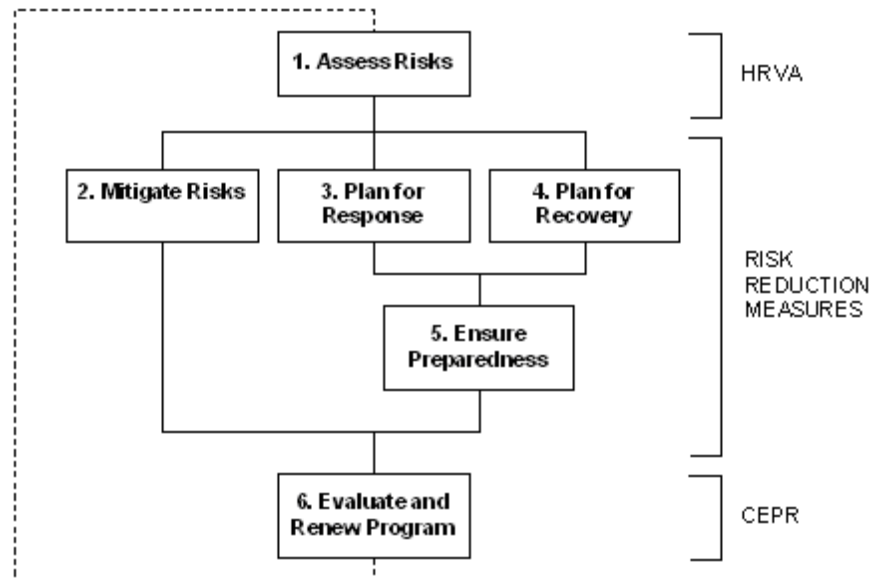
Information from British Columbia Hazard, Risk and Vulnerability Analysis Tool Kit, 2004

Objectives of Emergency Management

Risk Definitions¹

The concept of **risk** is illustrated by the tightrope walker. Pause for a minute to think about the risk to the person on the highwire. In this example, the risk to the tightrope walker is falling off and getting killed—a high-risk activity! Now consider that the highwire is only one metre above the ground. The falling **hazard** still exists and the chance of falling remains constant, but the risk is considerably

different than if the person were 100 meters above the ground. Thus, risk does not mean chance, probability or likelihood. Risk is a total concept of **likelihood** of occurrence of a hazard and the severity of possible **impacts**. Perhaps there is a crowd below the tightrope walker **vulnerable** to injury. The severity of impact to the tightrope walker and the crowd can be **mitigated** by a safety net, the chance of falling can be **reduced** by special training, and the extent of injury can be **mitigated** by emergency medical response capability.



Risk—the chance of injury or loss as defined as **a measure of the probability [likelihood] and severity** of an adverse effect to health, property, the environment, or other things of value.

Risk analysis—the systematic use of information to identify hazards and to estimate the chance for and severity of, injury or loss to individuals or populations, property, the environment, or other things of value.

Hazard identification—the process of recognizing that a hazard exists and defining its characteristics.

Consequences or impacts—an adverse effect to health, property, the environment, or other things of value.

Vulnerability—people, property, infrastructure, industry and resources, or environments that are particularly exposed to adverse impact from a hazard event.

Response and recovery capability—is defined as locally available strengths and capacities to reduce the impact of adverse conditions of a disaster. Impact severity and extent of vulnerability are dependent



2013 Washington State Enhanced State Hazard Mitigation Plan

upon the capability or capacity to reduce the severity of impact. A deficiency in response or recovery capability can create an unacceptable exposure.

Risk evaluation—the process by which risks are examined in terms of costs and benefits, and evaluated in terms of acceptability of risk considering the needs, issues, and concerns of stakeholders.

Risk reduction measure—an action intended to reduce the frequency and/or severity of injury or loss, including a decision not to pursue the activity. For example: flood control mitigation works or emergency response exercises.



2013 Washington State Enhanced State Hazard Mitigation Plan

Hazard List

The hazard list considered in the HRVA process is taken directly from the Emergency Program Management Regulation of the Emergency Program Act. Consider this list a starting point to assist with defining the scope of hazards affecting your community. You may wish to start with a list that includes several different scenarios for the same type of hazard, for example, a dangerous goods spill. You may find that one of these scenarios presents a greater risk, and a higher priority, than the others. While control options to reduce the risk in your emergency plan may be similar for each dangerous goods event, there may be a unique response which is worth noting—for example, evacuation routes or shelters.

Hazard Groups

Hazard

Accidents

- Air crashes
- Marine accidents
- Motor vehicle crashes

Atmosphere

- Snow storms
- Blizzards
- Ice storms and fog
- Hailstorms
- Lightning
- Hurricanes
- Tornadoes
- Heat waves

Dam failure

- Dam failure (includes foundations and abutments)

Disease and epidemics

- Human diseases
- Animal diseases
- Plant diseases
- Pest infestations

Explosions and emissions

- Gas and gas leaks (pipeline)
- Gas and gas leaks (gas wells)
- Mine
- Other explosions

Fire - urban and rural

- Fire (urban and rural - excludes interface fire)

Fire - wildfire and interface

- Wildfire (includes interface fire)

Geological

- Avalanches:
 - highways
 - other



2013 Washington State Enhanced State Hazard Mitigation Plan

	<ul style="list-style-type: none">• Debris avalanches and debris flows• Landslides:• Submarine slides• Coastal erosion• Expansive soils• Land subsidence
Hazardous materials	<ul style="list-style-type: none">• Hazardous spills- general (on site or transport routes)- radiation- infectious materials
Hydrologic	<ul style="list-style-type: none">• Drought• Erosion and accretion• Flooding• Ice jams• Storm surges
Power outage	<ul style="list-style-type: none">• Electrical power outage
Riots	<ul style="list-style-type: none">• Riots/public disorder
Seismic	<ul style="list-style-type: none">• Ground motion effects• Liquefaction• Tsunamis
Space object	<ul style="list-style-type: none">• Electromagnetic storms• Space object crash
Structural	<ul style="list-style-type: none">• Structural collapse
Terrorism	<ul style="list-style-type: none">• Terrorism (hostile act against state)
Volcanic	<ul style="list-style-type: none">• Ash falls• Pyroclastic flows• Lava flows• Mudflows

Hazard Definitions ⁱⁱ

The following hazard definitions were originally prepared by the Disaster Preparedness Resources Centre at the University of British Columbia at the request of the Provincial Emergency Program in order to provide information to municipalities, provincial and federal ministries and departments, local area coordinators and emergency planners. Some changes have been made to the original text.

Accidents



2013 Washington State Enhanced State Hazard Mitigation Plan

Air crash is an accident involving one or more aircraft that results in damage to aircraft, property or human injury or death. Most crashes occur near airports, however, they occur anywhere in the rugged terrain of British Columbia.

Marine accidents include collisions, groundings, strikings, explosions and fires, structural failures as well as accidental spills of petroleum products or chemicals, loss of cargo and human death or injury. Marine accidents can have local or widespread environmental and economic impact.

Motor vehicle crashes that involve a large number of passengers, or carry hazardous or explosive products that have the potential for a severe human or environmental impact are of concern.

Rail accidents occur when a train derails or collides with another train, motor vehicle, or obstruction on the rail tracks. Rail accidents have potential for a severe human or environmental impact.

Atmospheric Hazards

Snowstorms vary from light sprinkles of snow to accumulations of several metres. Similar to the effects of blizzards, snowstorms are, however, not often associated with high winds. Snowstorms impact upon transportation, powerlines and communications infrastructure, and agriculture.

Blizzards combined high winds (typically in the 90 to 130 kilometres per hour range), blowing snow, and low temperatures. The effects of the storm are always intensified by the wind chill factor associated with the high winds. Blizzard conditions occur most often in unforested areas where there are no trees present to break the effects of the wind. Blizzards impact upon transportation, buildings, powerlines and communications infrastructure, and agriculture. Blizzard conditions are often accompanied by freezing rain.

Ice storms and *ice fogs* cause accumulation of ice on structures. An ice storm combines high wind, freezing temperatures, and freezing rain or drizzle. An ice fog combines very cold temperatures, and a source of warm moisture. Ice accretion impacts upon transportation, buildings, powerlines and communications infrastructure.

Hailstorms are precipitation in the form of ice balls of five millimetres or more in size. Hailstorms impact upon agriculture and property.

Lightning can occur where there is moisture-laden instable air, ascending air and thunderclouds. Lightning impacts air transportation, powerlines and communications infrastructure and causes forest fires.

Hurricanes or tropical cyclones are defined as storms with wind speeds in excess of 110 kilometres per hour. Hurricanes cause injury as well as property and infrastructure damage because of high winds, flooding from heavy and rapid rainfall and storm surges from wind and low pressure.

Tornadoes are funnel clouds of very rapidly rotating air. At the centre is an intense low pressure of rapidly rising air. The tornado is a secondary formation of vortex activity in a higher cloud layer. The extreme wind velocities severely impact upon people, property and infrastructure.



2013 Washington State Enhanced State Hazard Mitigation Plan

Heat waves can be characterized by temperatures significantly above the mean for an extended period, or by a combination of high temperatures with high humidity and a lack of air motion. Heat waves impact upon the very young, the elderly and those with cardiovascular conditions. Heat waves also impact upon agriculture.

Dam Failure

Dam failure is a breach in the dam itself, its foundations, abutments, or spillway, which results in large or rapidly increasing, uncontrolled releases of water from the reservoir.

Disease and Epidemics

Human diseases are diseases and epidemics that affect people, cause death, have serious economic implications and form the basis for a mass casualty emergency response. These include epidemics such as meningitis, pandemic flu, hepatitis, E. coli, and other communicable diseases.

Animal diseases can be spread between animals and sometimes to humans. The threat of foreign animal disease, such as foot and mouth disease, is catastrophic impact on the economy.

Plant diseases caused by pathogens such as viruses, bacteria, fungi and algae impact upon crops, residential trees, and forests. A widespread outbreak could have severe economic consequences.

Pest infestations are classified as foliage feeding or root feeding. A widespread outbreak could have severe economic consequences.

Explosions and Emissions

Pipeline and gas well leaks and explosions occur when natural gas or gasoline pipelines, valves or components rupture, by accident, by mechanical failure or corrosion. Gas leaks can also be caused by natural hazards such as earthquakes or landslides.

Mine explosions are usually caused by a buildup of explosive gases underground in the mine. These gases can be set off by a spark or by miners entering, working or leaving the area. Errors with the handling of explosives underground can also cause life-threatening explosions.

Fire—Urban and Rural

Urban fires are fires that occur in a residential, commercial or industrial community. Rural and urban fires occur on a frequent basis in many parts of the province, and of provincial concern are the fires that cause a large number of deaths or injuries, those that are beyond the ability of the local resources to respond or those that cause severe economic losses. For interface fires, see wildfires.

Geological

Avalanche is a movement of snow and ice in response to the force of gravity down an incline. Factors such as the type or nature of snow, ambient temperature and wind conditions are critical in avalanche potential. Conditions such dense, wet snow falling on dry, loosely packed snow may give risk to an avalanche. Avalanches impact upon people engaged in recreation as well as transportation and communications infrastructure.



2013 Washington State Enhanced State Hazard Mitigation Plan

Debris avalanches and debris flows. Debris flows are a form of rapid mass down-slope movement of a slurry of loose soils, rocks and organic matter. Debris avalanches are extremely rapid debris flows of mud, rock, brush, trees and other debris propelled by torrential rains. About one half of damaging landslides in British Columbia are debris flows which impact life and/or property.

Landslide is a general term used to describe the down-slope movement of soil, rock and organic materials under the influence of gravity. It also describes the landform that results. Landslides cause property damage, injury and death and adversely affect a variety of resources. For example, water supplies, fisheries, sewage disposal systems, forests, dams and roadways can be affected for years after a slide event. The negative economic effects of landslides include the cost to repair structures, loss of property value, disruption of transportation routes, medical costs in the event of injury, and indirect costs such as lost timber and lost fish stocks. Water availability, quantity and quality can be affected by landslides.

Submarine slides involve the underwater down slope movement of slope materials under the influence of gravity. They may be triggered by seismic events or by the gradual deposition and slumping of sediments. A submarine slide may impact underwater infrastructure or generate a tsunami.

Land subsidence occurs when a surface has been undermined by natural or human causes and deformation and ground movement occur. Subsidence can impact upon property, facilities and ground water.

Hazardous materials

Hazardous materials spills on site or transport route is any uncontrolled release of material posing a risk to health, safety, and property. Transport routes include air, marine, rail and roads. Spills are classified in British Columbia as Urgent (Code II) or Non-Urgent (Code I). Code II spills pose a threat that may require evacuation. Other hazardous materials include radiation and infectious materials.

Hydrologic

Drought results from an abnormal water deficiency. The impact can be crop failure, forest fire conditions, dust storms, insufficient and polluted water supplies and other ecological and economic effects.

Erosion and accretion is the wearing away and accumulation of land by natural forces such as wave action, river and tidal currents and precipitation. Accretion in rivers increases the risk of flooding. Erosion of shoreline slopes increases the risk of slope failure. These processes can result in property damage.

Local flooding may be associated with an extreme hydrologic event such as a record rainfall or by poor or blocked drainage. Flooding impacts upon transportation, property and agriculture.

Freshet flooding is a late spring event caused by the melting of snow pack. Flooding impacts upon transportation, property and agriculture.



2013 Washington State Enhanced State Hazard Mitigation Plan

Ice jams are an accumulation of broken river ice caught in a channel, usually at a shallow, narrow or curved portion, frequently producing local floods during the spring breakup. Ice jams can also occur on freeze-up. Ice jams impact communities and agriculture by flooding behind the ice jam, or by flash flooding by its sudden release.

Storm surges are increases in water levels which exceed normal tide heights. They are caused by winds driving water shoreward and often by a rise in water level due to a low pressure system. Storm surge flooding impacts people and property.

Power Outages

Power outages occur on a regular basis, however, they become a concern when the power outage is for a significant amount of time, when the temperatures are very low, or critical infrastructure, persons, livestock or businesses are affected.

Riots

Riots are violent public disorders by a group of persons with either a common or random intent to destroy property, assault persons, or otherwise disturb the peace.

Seismic

Earthquake or *ground motion* is defined as violent shaking of the ground accompanying movement along a fault rupture. Seismic energy traveling in waves may cause damage to structures, trigger landslides, liquefaction or other geologic event, or generate tsunamis. Impacts from earthquakes can be widespread and severe.

Tsunamis or seismic sea waves result from offshore earthquakes where there is sudden subsidence or uplift. Impacts include coastal flooding, which can be intensified in inlets. This can destroy homes and property. Possible death and suffering may be mitigated with warning. Proximity to the source of the tsunami defines the warning period. A local event may provide 15 minutes warning; a distant event may provide five or more hours warning.

Space Objects

Space objects crash is the result of either a technological or natural object from space penetrating the earth's atmosphere and crashing on earth causing damage. This can be a meteor, meteorite, asteroid or other naturally occurring space object, or it can be a man-made satellite, space station, or space craft.

Structural

Structural collapse occurs when a building or structure collapses due to engineering or construction problems, metal fatigue, changes to the load bearing capacity of the structure, human operating error or other cause such as earthquake, flood, fire, explosion, snow or ice buildup.

Terrorism

Terrorism is considered to be a hostile act committed against the state and designed to exercise the use of terror, especially as a means of coercion. Most common forms include bomb threat, explosions from bombs, sabotage, kidnapping or hostage situations. Other terrorism threats include those from chemical, biological, radiological or nuclear (CBRN) weapons.



2013 Washington State Enhanced State Hazard Mitigation Plan

Volcanic

Ash falls occur where fine volcanic ash has been ejected out of a vent into the atmosphere, possible transported by upper level winds, and deposited on the earth. Impacts include health hazards, pollution of water supplies, disruption of transportation and structural collapse.

Pyroclastic flows are sudden and very rapid flows of hot gas, ash and rock particles down the slopes of a volcano associated with explosive eruptions. They destroy everything in their path.

Lava flows are slow speed flows of molten rock. People can evacuate, but structures are usually destroyed when in the path of a lava flow.

Mud flows are slurries of water and rock particles. These can occur long after an eruption has deposited ash. Mud flows are extremely destructive but usually confined to valley bottoms.

Wildfire

Wildfire exists when there is uncontrolled burning in grasslands, brush or woodlands. Interface fire is wildfire that impacts or threatens adjacent property and infrastructure or human lives.

Vulnerability

Vulnerability is defined as people, property, infrastructure, industry and resources, or environments that are particularly exposed to adverse impact from a hazard event. Consider a hazard scenario with a vulnerable population, such as an elementary school along an earthquake fault where a large number of casualties might occur. This scenario might have a consequence magnitude rating of "very high". The recognition of vulnerabilities identifies opportunities for risk reduction. For example, if a risk reduction measure were implemented to give the school a seismic upgrade, then the consequence rank is lower and the overall risk might become acceptable.

There are four groups of vulnerabilities to consider in your hazard scenarios: social, physical, economic and environmental. Some examples include:

Social

- Confined – penitentiaries or jails
- Elderly – group homes or retirement complexes
- Gender – mothers and children, violence against women
- High density – shopping malls, theatres, stadiums, high-rise buildings
- Infirm – hospitals
- Language – ethnic centres
- Persons with disabilities – vision, hearing, mobility, mental, dependency
- Young – schools or recreation centres

Physical

- Bridges
- Communications systems – telephone, radio, cellular, television
- Critical infrastructure
- Gas and oil transmission and distribution pipelines
- Hazardous waste sites
- Historic sites
- Mobility of population
- Power transmission towers
- Property and infrastructure in close proximity to hazard
- Trailer parks and campgrounds



2013 Washington State Enhanced State Hazard Mitigation Plan

- Transportation – routes, terminals, systems: road, rail, air, water
- Water reservoirs and hydro dams

- Resource degradation or depletion – forests
- Sensitive areas – coastline or fisheries

Economic

- Farm land and animals
- Lack of economic diversity – single major employer or tourism
- Limited access to credit
- Minimal access to critical services
- No insurance
- Poor – social housing or low-rent areas

Environmental

- Areas of biodiversity and ecological value – wetlands
- Parks

Fatality:

Rank Description Criteria Example

- 1 very low 0-4 No deaths
- 2 low 4-10 Avalanche
- 3 high 10-50 Mine explosion
- 4 very high 50+ Plane crash

Injury:

Rank Description Criteria Example

- 1 very low 0-4 Auto accident
- 2 low 4-50 Bus accident
- 3 high 50-2000 Contaminated water
- 4 very high 2000+ Pandemic flu

Critical facilities (hospitals, fire/police services, etc.):

Rank Description Criteria Example

- 1 very low temporary relocation Evacuation of a shelter
- 2 low closure of a few days School
- 3 high loss of 50% of capability First responders
- 4 very high long term disruption Hospital destroyed

Lifelines (water, gas, power, etc.):

Rank Description Criteria Example

- 1 very low temporary interruption Ferry service

Consequence Severity

There are seven categories of impacts to be assessed for each hazard:

- fatality;
- injury;
- critical facilities;
- lifelines;
- property damage;
- environment; and
- economic and social.

- 2 low interruption for a few days Power
- 3 high interruption for a week Water supply
- 4 very high long term disruption Bridge collapse

Property damage:

Rank Description Criteria Example

- 1 very low minimal damage Flood damage–2 homes
- 2 low localized damage Mud slide–several homes
- 3 high localized and severe Interface fire–community
- 4 very high widespread and severe Dam failure

Environmental impact:

Rank Description Criteria Example

- 1 very low minimal damage House fire
- 2 low localized damage Harbour oil spill
- 3 high localized and severe Toxic chemical spill
- 4 very high widespread and severe Radiation contamination

Economic and social impact:

Rank Description Criteria Example

- 1 very low temporary impact Power loss
- 2 low temporary and widespread Loss of lifeline
- 3 high extended and widespread Pandemic flu



2013 Washington State Enhanced State Hazard Mitigation Plan

4 very high long term disruption Foot and

mouth disease

Hazard Likelihood Measure of likelihood

Frequent or very likely
Moderate or likely
Occasional, slight chance
Unlikely, improbable
Highly unlikely, rare event
Very rare event

Return period in years

Every 1 – 3 years
Every 3 – 10 years
Every 10 – 30 years
Every 30 – 100 years
Every 100 – 200 years
Every 200 – 300 years

Frequent or very likely to occur events usually have a high number of recorded incidents or anecdotal evidence. For example, a rural valley that is subject to some degree of flooding every year or so.

Moderate or likely to occur hazards also have a historical record but occur with a frequency of three to ten years. For example, an urban interface fire threat in a region that experiences forest fires every year.

Occasional or slight chance means events are those that occur infrequently. There may be little recorded historical evidence and a return interval of 10 to 30 years is possible. For example, a rail accident where dangerous goods are released.

Unlikely or improbable refers to hazards that are not expected to occur more frequently than once every 30 to 100 years. There may be no historical incidents in the community. For example, a commercial airplane ground collision with a total loss of life.

Highly unlikely or rare events are extremely unlikely and have a return period of 100 to 200 years. For example, a "one hundred year flood."

Very rare events may happen every 200+ years. For example, a magnitude 8 earthquake might occur every 200 years somewhere in coastal British Columbia.

Qualitative Risk Assessment: British Columbia PEP Method Slide (unable to find digital version via internet key word search) has Deaths, Injuries, Critical Facilities, Lifelines, Property Damage, Environmental Impact, Econ/Social Impact, Likelihood categories on the vertical with very low, low, high, very high on the horizontal axis with definitions filled in for each column/row. It is more extensive than the current HIVA FPEEP system.

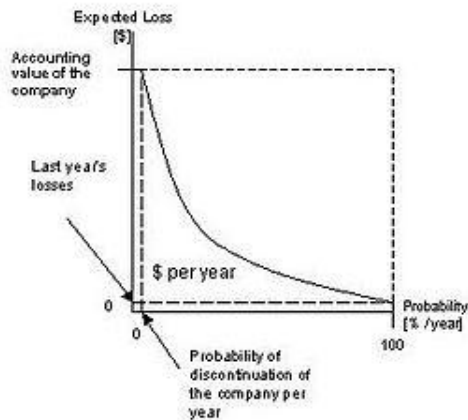
Wikipedia

Risk assessment consists of an objective evaluation of risk in which assumptions and uncertainties are clearly considered and presented. Part of the difficulty in risk management is that measurement of both of the quantities in which risk assessment is concerned - potential loss and probability of occurrence - can be very difficult to measure. The chance of error in measuring these two concepts is large. Risk with



2013 Washington State Enhanced State Hazard Mitigation Plan

a large potential loss and a low probability of occurring is often treated differently from one with a low potential loss and a high likelihood of occurring. In theory, both are of nearly equal priority, but in practice it can be very difficult to manage when faced with the scarcity of resources, especially time, in which to conduct the risk management process.

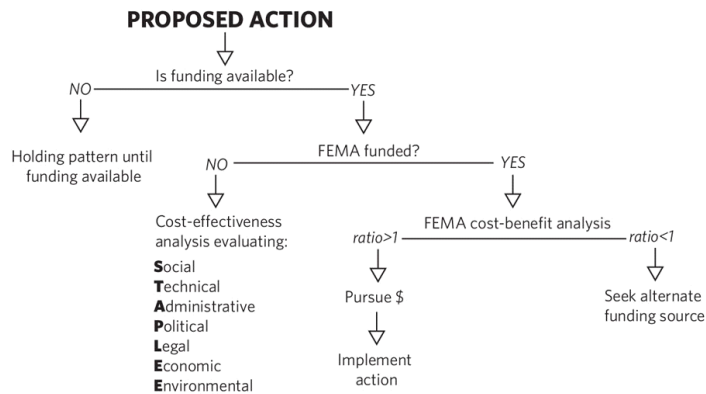


Quantitative risk assessments include a calculation of the [single loss expectancy](#) (SLE) of an asset. The single loss expectancy can be defined as the loss of value to asset based on a single security incident. The team then calculates the [Annualized Rate of Occurrence](#) (ARO) of the threat to the asset. The ARO is an estimate based on the data of how often a threat would be successful in exploiting a vulnerability. From this information, the [Annualized Loss Expectancy](#) (ALE) can be calculated. The annualized loss expectancy is a calculation of the single loss expectancy multiplied by the annual rate of occurrence, or how much an organization could estimate to lose from an asset based on the risks, threats, and vulnerabilities. It then becomes possible from a financial perspective to justify expenditures to implement countermeasures to protect the asset.

[Barry Commoner](#), [Brian Wynne](#) and other critics have expressed concerns that risk assessment tends to be overly quantitative and reductive. For example, they argue that risk assessments ignore qualitative differences among risks. Some charge that assessments may drop out important non-quantifiable or inaccessible information, such as variations among the classes of people exposed to hazards. Furthermore, Commoner and O'Brien claim that quantitative approaches divert attention from precautionary or preventative measures.^[8] Others, like [Nassim Nicholas Taleb](#) consider risk managers little more than "blind users" of statistical tools and methods.^[9]



2013 Washington State Enhanced State Hazard Mitigation Plan



Source: Community Service Center's Partnership for Disaster Resilience at the University of Oregon, 2006

<p>FEMA Hazard Mitigation How-to Guides</p>	<p>These guides explain specific planning topics in and provide adaptable tools to meet or exceed FEMA's requirements.</p>	<p>Getting Started: Building Support For Mitigation Planning (FEMA 386-1)</p> <p>Understanding Your Risks: Identifying Hazards And Estimating Losses (FEMA 386-2)</p> <p>Developing The Mitigation Plan: Identifying Mitigation Actions And Implementing Strategies (FEMA 386-3)</p> <p>Bringing the Plan to Life: Implementing the Hazard Mitigation Plan (FEMA 386-4)</p> <p>Using Benefit-Cost Review in Mitigation Planning (FEMA 386-5)</p> <p>Integrating Historic Property and Cultural Resource Considerations into Hazard Mitigation Planning (FEMA 386-6)</p> <p>Integrating Manmade Hazards Into Mitigation Planning (FEMA 386-7)</p> <p>Multi-Jurisdictional Mitigation Planning (FEMA 386-8)</p> <p>Using the Hazard Mitigation Plan to Prepare Successful Mitigation Projects (FEMA 386-9)</p>
---	--	--



2013 Washington State Enhanced State Hazard Mitigation Plan

References

ⁱ British Columbia, Provincial Emergency Program, Ministry of Public Safety and Solicitor General. Hazard, Risk and Vulnerability Analysis Tool Kit, January 2004.

ⁱⁱ See Pearce, L. 1997. British Columbia: Hazard, Risk and Vulnerability Analysis. Vol. 1 - Updated 1997.